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LITTER FALL IN A YOUNG DOUGLAS-FIR STAND AS INFLUENCED BY THINNING

by

Donald L. Reukema

Litter fall plays a fundamental role in soil formation and fertility and thus has a basic influence on forest productivity. To determine amount and timing of litter fall and how these factors are influenced by thinning, a study was begun in 1950 on Voight Creek Experimental Forest,[1] in western Washington. Resulting information is of considerable scientific interest and provides background data for studies, now underway, of nutrient cycling in forest stands. Results of an analysis made at the end of the first 6 years were reported by Dimock in 1958.[2]

STUDY AREA

The area sampled ranges in elevation from 920 to 1,140 feet. The land slopes generally to the north and west. Soils are developed on Pleistocene glacial material and have gravelly sandy loam and sandy clay loam textures. The nearest weather station[3] receives an average annual precipitation of 46 inches, of which 15 inches fall during the period April to September. Average annual temperature is 50.4° F.; the April-to-September average is 58.0° F.

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[1] Maintained by the Pacific Northwest Forest and Range Experiment Station in cooperation with St. Regis Paper Co.

[2] Dimock, Edward J., II. Litter fall in a young stand of Douglas-fir. Northwest Sci. 32: 19-29, illus. 1958.

[3] Buckley, Wash., elevation 685 feet.

The present forest stand became established about 1912, following cutting and repeated burns. Douglas-fir accounts for about 80 percent of the cubic volume and is dominant except in moist areas, where red alder, bigleaf maple, and black cottonwood occur. There is a scattering of western hemlock, western redcedar, and bitter cherry throughout the stand.

DESIGN OF STUDY

The Experimental Forest is devoted primarily to study of various commercial thinning regimes. Thinnings were begun in the fall of 1948, when the stand was 37 years old, to compare four treatments: (1) heavy thinning at 9-year intervals; (2) medium thinning at 6-year intervals; (3) light thinning at 3-year intervals; and (4) no thinning. Thinnings have tended to be from below, but most large, limby dominants have been removed and many codominants have been cut to free crowns of adjacent trees.

The litter-fall study has been conducted on one replication (four 17-1/2-acre compartments) of the thinning experiment. Average site index in each thinned stand is 145 feet, and in the unthinned stand, 120 feet. Basal areas before initial treatment averaged about 155 square feet per acre in the unthinned and heavily thinned stands and 180 square feet in the lightly and moderately thinned stands. Initial heavy, medium, and light thinnings reduced basal areas to about 100, 140, and 150 square feet per acre, respectively.[4/] Subsequent thinnings altered the relative standings of the four treatments as illustrated in figure 1. Average basal areas on the lightly, moderately, and heavily thinned stands have been 86, 84, and 67 percent, respectively, of the basal area on the unthinned stand.

Litter fall is sampled by 40 systematically spaced traps--10 in each treatment compartment. The trap tops, measuring 2 by 3 feet, allow transmittal of seed and coniferous foliage to the interior and intercept heavier debris, such as branches, twigs, and hardwood leaves.[5/] Seed and litter are collected five times a year on a schedule

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[4/] Based on fifteen 1/5-acre plots per treatment.

[5/] Material larger than about three-fourths inch in diameter (other than cones) has not been collected.

designed to sample seed dissemination effectively: August 22, October 1, October 21, December 10, and April 9.[6/] Collected litter is ovendried and weighed.

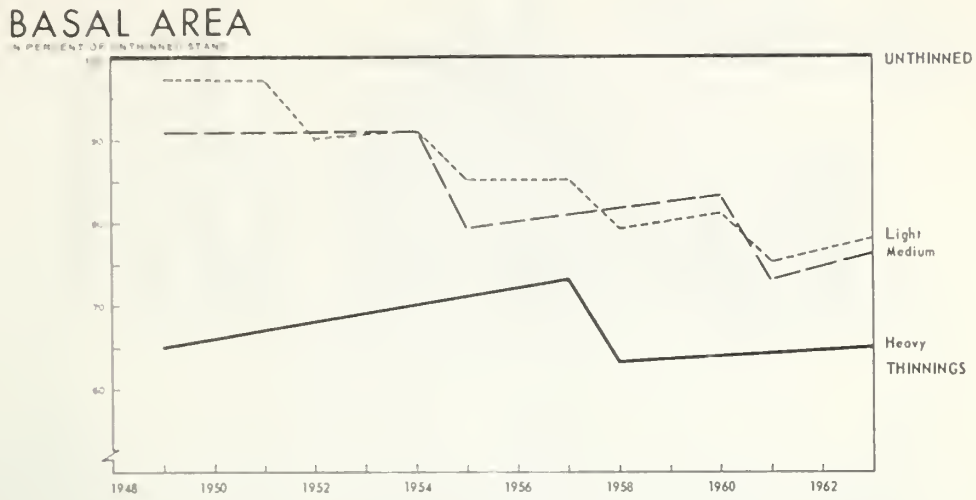

Figure 1.--Relative trends of annual basal area growing stock.

RESULTS

Analyses of variance showed differences between treatments, years, and collection periods to be highly significant. Treatment X year interaction was nonsignificant, but treatment X period and period X year interactions were significant.

Annual and Seasonal Variations

Variations in amount of annual litter fall have been considerable, the maximum being more than three times the minimum (fig. 2). Total material falling in 1954 was greatest up to that time, but has been exceeded in all subsequent years. Peaks occurred in 1955 due to abnormal November cold,[7/] in 1958[8/] because of heavy winds, and in 1960 due to an accumulation of wet, heavy snow.

[6/] Actual collection dates have deviated slightly. This paper is concerned only with the litter fall aspect of the study.

[7/] Duffield, J. W. Damage to western Washington forests from November 1955 cold wave. U.S. Forest Serv. Pac. NW. Forest & Range Expt. Sta. Res. Note 129, 8 pp., illus. 1956.

[8/] Data for April 9 to October 21 are missing, but a peak rate of litter fall occurred between October 21 and December 10, 1958.

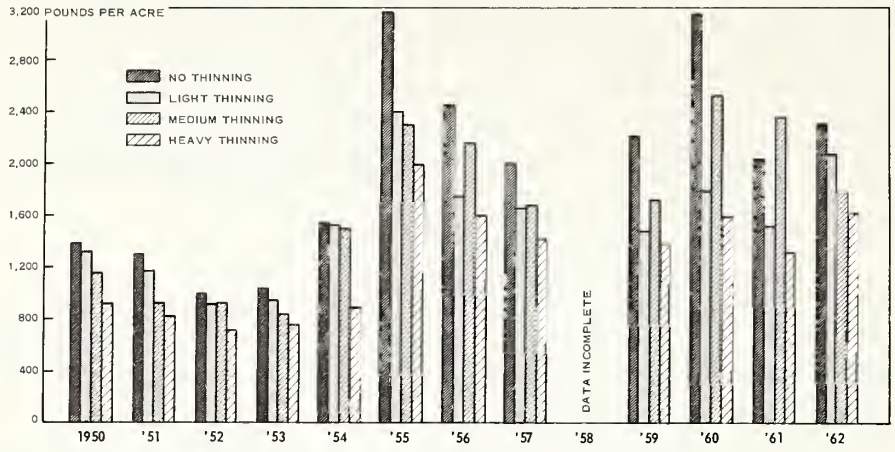

Figure 2.--Amount of annual litter fall, by year and treatment.

Rate of litter fall generally reached a maximum in October and a minimum about April (fig. 3). However, in 1955, 1958, and 1960, abnormal weather conditions noted above resulted in greater rates of fall in November than in October; the cold wave of November 1955 was followed by excessive litter fall until October of the following year. In general, about half of the total litter fell in October and November. Average daily fall for the first 3 weeks in October was 16 pounds per acre, whereas during the 8-1/2-month period, December 10 through August 22, the average was only 2.4 pounds per acre.

Effect of Treatment

Over the 13-year period sampled,[9/] the unthinned stand produced the most litter, averaging 1,974 pounds per acre. Treated stands averaged 1,666, 1,555, and 1,262 pounds per acre for medium, light, and heavy thinnings, respectively. All differences between treatment averages are significant, except that between medium and light thinnings.

On the average, litter fall was approximately proportional to basal area--about 85 percent of unthinned on lightly and moderately thinned plots and 65 percent on heavily thinned. Variation in basal

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[9/] Annual averages are based on 12 years, since the 1958 data are incomplete.

DAILY LITTER FALL

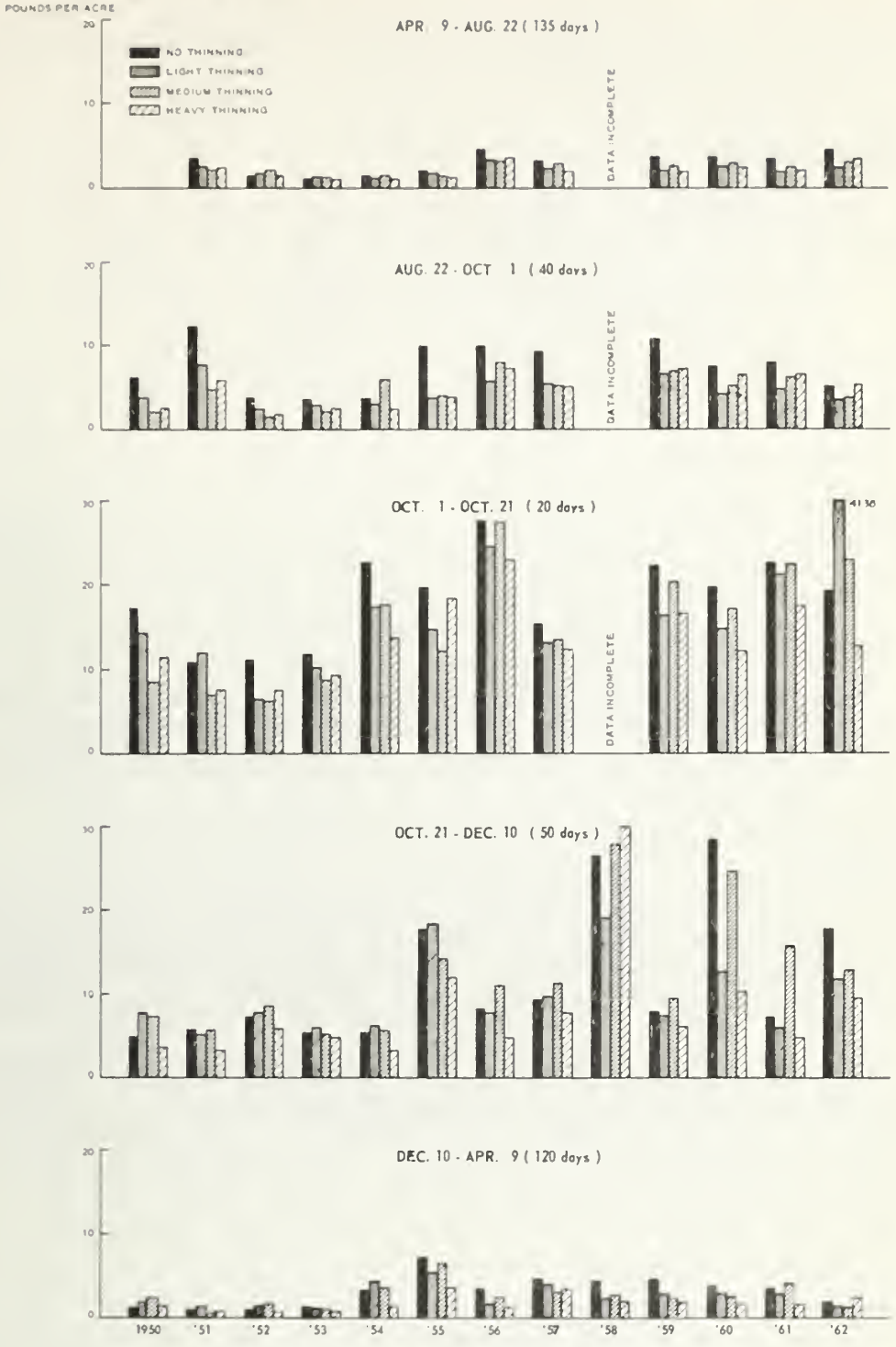

Figure 3.--Seasonal rates of daily litter fall, by year and treatment.

area followed a definite trend, influenced by growth and cutting (fig. 1), whereas year-to-year fluctuations in relative litter fall overshadowed any general trend that might exist (fig. 4).

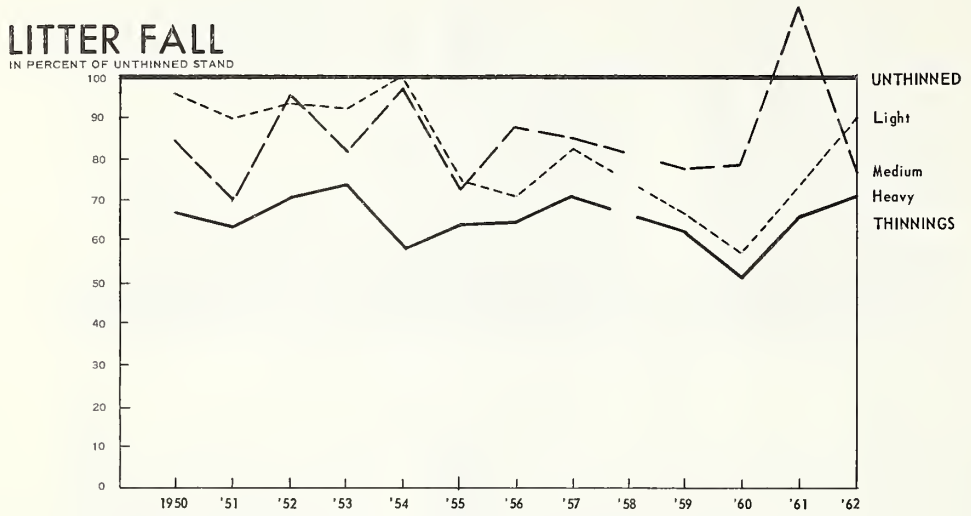

Figure 4.--Relative standings between treatments in amount of litter fall.

The slight variation in proportion of total litter fall deposited during each of the five collection periods for the four treatments (fig. 3) is probably due more to differences in stand composition than to effects of treatment.

Discussion

Composition of litter reaching the forest floor under a Douglas-fir stand is varied, consisting of needles, twigs, branches, buds, cones, bark, and leaves and fruits of hardwoods and lesser vegetation.

According to Harlow and Harrar,[10/] Douglas-fir needles generally persist for 8 years or more; Mathews[11/] indicated 3-1/2 to 5-1/2 years. Lengths of shoots and number and size of needles depend in part upon climate and may, therefore, vary considerably from year

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10/ Harlow, W. H., and Harrar, E. S. Textbook of dendrology. Ed. 3, 555 pp., illus. New York: McGraw-Hill Book Co., Inc. 1950.

11/ Mathews, J. D. Some applications of genetics and physiology in thinning. Forestry 36(2): 172-180. 1963.

to year. In a nearby stand, thinning that greatly stimulated stemwood production had virtually no effect on amount of annual branch elongation. If we assume that thinning also had no effect on number and size of needles per unit twig length, then a thinned stand, with fewer trees, would have less total foliage than an unthinned stand.

Both live and dead twigs are shed as a result of snow and wind and whipping action within interlaced crowns. Loss of live twigs would, of course, result in loss of young needles.

Hardwoods and lesser vegetation add considerably to total litter fall. Their growth tends to be stimulated by thinning; thus, the proportion of such litter to the total is higher in thinned stands.

The actual thinning operation brings much litter to the ground in the form of tops of harvested trees and branches stripped from residual trees. Unfortunately, litter from this source is not adequately sampled in this study since trees were felled away from the traps to prevent damage to them. However, any such litter that did fall on the traps was collected. Thus, our sample is primarily of normal fall from the residual stand, but it does contain a small part of the thinning debris.

Sources of peak amounts of litter fall are easily explained; the general trend is not. It was noted immediately following the 1955 cold wave that defoliation was heavy and needles remaining on the trees browned. Amount of litter collected was more than normal into October of the following year. When crowns were examined in 1958, very few needles more than 3 years old were present. All of this indicates that the freeze resulted in loss of many needles that normally would have been shed over the ensuing years. It would seem that litter fall should have tended to diminish after 1956; instead, it consistently remained higher than in any year prior to 1955.

There are some factors that tend to offset this excessive loss of needles. Probably most important is the considerable sprouting from dormant buds during the years immediately following the freeze. However, in light of needle longevity mentioned earlier, this would not be expected to start contributing to litter fall before 1959 at the earliest.

SUMMARY AND CONCLUSIONS

A 13-year record from a young Douglas-fir stand illustrates how amount and timing of litter fall are affected by thinning treatment and climatic variations.

During the 13-year period, maximum annual litter fall was more than three times the minimum, as a result of climatic conditions. Average litter fall in the unthinned stand was 1,974 pounds per acre per year. Rate of fall was at a minimum about April and usually reached a maximum in October. Generally, about one-half of the total fell during October and November.

On the average, litter fall over this 13-year period was nearly proportional to basal area. Thus, thinning reduced amount of litter fall. There were only minor variations between treatments in the proportion of total litter deposited during each of five seasonal collection periods.

Results are discussed in light of factors influencing litterfall.